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EVALUATION OF GROWTH AND CARCASS TRAITS BETWEEN 42 AND 58 DAYS OF AGE IN CHICKENS DIVERGENTLY SELECTED FOR BODY WEIGHT

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SUMMARY

The effect of divergent selection for high (H) or low (L) body weight at eight weeks of age for 25 generations on growth and carcass traits between 42 and 58 days of age was studied. The chicks were reared in individual cages under standard management conditions. Selection for low 8-week body weight has resulted in higher relative body weight increase for the period from 42 to 58 days of age compared to chickens from the high line. Body weight increased by about 72 % in the low line and by about 56 and 44 %, respectively in the males and females in the high line. In both lines of chickens dressing out percentage and the percentage of abdominal, subcutaneous and total fat increased with body weight, whereas percentage of *m. pectoralis superficialis* ***and*** *m. pectoralis profundus* ***remained roughly constant. Percentage of skin decreased with increasing of body weight. In both lines females had a higher percentage of total fat than males. There was evidence that total fat content increased independently of animal body weight with a certain age. Fixed age comparisons of feed conversion ratios showed no differences in feed conversion between the two divergently selected lines of chicks.***

Key- words: chickens, divergent selection, growth, carcass traits

INTRODUCTION

Growth is merely defined as an increase in size influenced by genetic, physiological and environmental factors among which the feed conversion is the most important. Total increase in animal body weight consists of increase of weight of some body parts. Various body parts grow differently. Increase in animal size causes a decrease in share of inner body parts (digestive and respiratory systems and other inner parts that are not used in human nutrition) while shares of muscle and fat tissues increase. Recently, offer of various parts of fresh poultry meat as well as its products has been augmented. In order to meet the consumers' expectations and to use various parts of meat economically we should predict relative weights of body parts in different growth periods of an animal. It is also important to compare relative weights of various body parts between lines and sexes. The objective of our research was to monitor the growth dynamics and changes in relative shares of various body parts and tissues from 42 to 58 days of age in two lines of chickens that had been selected for high and low growth respectively.

MATERIAL AND METHODS

Eighty-eight chickens of two lines that had been selected for high (D+) and low (D-) body weight respectively at the age of 8 weeks for 25 generations were used in a trial. From hatching to 35 days of age, chickens were kept in floor system following by individual cage system. Animals were adapting to new environment for 7 days. At the beginning of the trial animals were 42 days old, and the trial period lasted for 16 days. Animals were fed pellets of complete mixture (11.13 MJ ME/kg; crude protein=20.3 %; crude fat=2.0 %; crude fibre=2.3 %, ash=5.5 %) *ad libitum*. Animals were weighed and feed intake was monitored in a four-day interval, when also a randomly chosen animals were slaughtered. Due to comprehensive volume of data only results from the slaughter on 42 and 58 days of age are presented here.

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Number of animals slaughtered within each of four experimental groups (D+ males, D+ females, D- males, D- females) was six at the age of 42 days and four in the next four ages (46, 50, 54 and 58 days of age). The total number of animals weighed and monitored for feed intake in each of four abovementioned experimental groups was 22 at the age of 42 days, 16 at the age of 46 days, 12 at the age of 50 days, 8 at the age of 54 days and 4 at the age of 58 days. Animals were weighed just before the slaughter, however, after slaughter carcasses with necks and lower parts of legs were weighed again. The 24 hours chilling at + 4°C was followed by dissection of carcasses. The following body parts and tissues were weighed and separated: chilled carcass, skin on neck, fat on neck, skin on carcass, subcutaneous fat, abdominal fat, *m. pectoralis superficialis* and *m. pectoralis profundus*. The shares of individual body parts were expressed in relation to the weight of chilled carcass.

Statistical analysis

Data were processed by the statistical procedure GLM (General Linear Models) of the programme package SAS/STAT (SAS/STAT, 1990). The following statistical model was used:

$y_{ijkl} = \mu + G_i + S_j + A_k + GS_{ij} + GA_{ik} + SA_{jk} + GSA_{ijk} + e_{ijkl}$

where: y_{ijkl} monitored value; μ mean value of population; G_i genotype effect (i = 1, 2); S_j sex effect (j = 1, 2); A_k age effect (k = 1, 2); GS_{ij} genotype – sex interaction; GA_{ik} genotype – age interaction; SA_{jk} sex – age interaction; GSA_{ijk} genotype – sex - age interaction; e_{ijkl} residual.

RESULTS AND DISCUSSION

Growth traits

Body weight increased more in males than in females of the same genotype (Table 1). Significant differences between sexes were noticed in high (D+) line at all ages. The same is true of low (D-) line except at the age of 58 days. Apparently non-logical result of females (from high weight line at the age of 54 days) weighed less than at the age of 50 days could be explained with small samples and random sampling of animals that were sent to slaughter.

Table 1. Body weight of various genotypes of chicks (D+, D-) and sex at different age (g)

Age (days)	D+		D-		SEM
	Males	Females	Males	Females	
42	$1868.8^{a}{}_{A}$	$1682.7^{b}{}_{A}$	$614.3^{c}{}_{A}$	$510.2^{d}{}_{A}$	56.11
46	$2153.8^{a}{}_{B}$	$1941.7^{b}{}_{B}$	$727.5^{c}{}_{AB}$	$593.2^{d}{}_{AB}$	69.57
50	$2360.2^{a}{}_{C}$	$2148.0^{b}{}_{C}$	$852.5^{c}{}_{BC}$	$666.5^{d}{}_{ABC}$	68.72
54	$2745.2^{a}{}_{D}$	$2104.2^{b}{}_{BC}$	$971.7^{c}{}_{CD}$	$763.0^{d}{}_{BCD}$	68.72
58	$2920.0^{a}{}_{D}$	$2427.0^{b}{}_{D}$	$1060.0^{c}{}_{D}$	$878.0^{c}{}_{D}$	70.41

a,b – estimated mean values between groups (lines) differ statistically significantly ($P \leq 0.05$).
A,B – estimated mean values within groups (columns) differ statistically significantly ($P \leq 0.05$).

Body weight in males of both lines increased at higher rate compared to females, while D- chicks grew at higher rate than D+ chicks (Table 2).

Table 2. Changes in relative values of body weight in chicks between 42 and 58 days of age

Age (days)	D+		D-	
	Males	Females	Males	Females
42	100.0	100.0	100.0	100.0
46	115.3	115.4	118.4	116.3
50	126.3	127.7	138.8	130.6
54	146.9	125.0	158.2	149.5
58	156.3	144.2	172.6	172.1

In the males of the low body weight line feed conversion in the first period (42 – 46 days) was low whilst it improved further on and worsened again in the last four days of fattening (Table 3).

Table 3 The average feed conversion (kg/kg) in chicks at different age

Age (days)	D+		D-		SEM
	Males	Females	Males	Females	
42-46	2.285 [a]	2.689 [a]	2.704 [a]	2.442 [a]	0.2240
46-50	2.716 [a]	2.979 [a]	2.246 [a]	2.642 [a]	0.3050
50-54	2.550 [a]	2.961 [a]	2.693 [a]	2.397 [a]	0.1798
54-58	2.985 [a]	3.237 [a]	3.007 [a]	2.586 [a]	0.3642

a,b – estimated mean values between groups (lines) differ statistically significantly($P \leq 0.05$).

In D+ males and D- females feed conversion showed fluctuation over the experimental periods. Differences in feed conversion were neither statistically significant between sexes nor between lines. Similar results were reported by Dunnington and Siegel (1996) who fed animals *ad libitum* and found no differences in feed conversion between the two divergently selected lines of chicks for body weight at the age of 8 weeks.

Carcass traits

Dressing out percentage (weight of chilled carcass × 100/body weight of animal before slaughtering) increased with age of an animal. At the same age D+ males had the highest dressing out percentage and the lowest was found in D- females. Dressing out percentage was significantly different between sexes in line D+ at the age of 42 days (Table 4).

Table 4. Dressing out percentage in D+ and D- chicks at two different ages

Age (days)	D+		D-		SEM
	Males	Females	Males	Females	
42	78.06 [a] [A]	75.45 [b] [A]	72.82 [c] [A]	71.91 [c] [A]	0.696
58	80.20 [a] [B]	79.27 [a] [B]	76.09 [b] [B]	75.47 [b] [B]	0.874

a,b – estimated mean values between groups (lines) differ statistically significantly ($P \leq 0.05$).
A,B – estimated mean values within groups (columns) differ statistically significantly ($P \leq 0.05$).

The amount of subcutaneous fat represented the weight of fat removed from the inside part of skin and from carcass surface without skin. The abdominal fat was represented by deposits of easily separated fats around digestive organs (proventriculus, gizzard, intestine) and cloaca. The sum of subcutaneous and abdominal fats resulted in the amount of total fats (Table 5).

Table 5. Shares of subcutaneous, abdominal and total fat in chick carcasses of two genotypes, sexes and at two different ages

Trait	Age (days)	D+		D-		SEM
		Males	Females	Males	Females	
Subcutaneous fat	42	4.64 [a] [A]	5.90 [b] [A]	3.49 [ac] [A]	4.42 [ac] [A]	0.565
	58	8.22 [a] [B]	10.37 [b] [B]	6.19 [c] [B]	6.07 [c] [B]	0.709
Abdominal fat	42	3.21 [a] [A]	4.89 [b] [A]	0.98 [c] [A]	1.67 [d] [A]	0.312
	58	4.61 [a] [B]	6.09 [b] [B]	2.00 [c] [B]	2.28 [c] [A]	0.392
Total fat	42	7.85 [a] [A]	10.80 [b] [A]	4.48 [c] [A]	6.29 [ac] [A]	0.764
	58	12.84 [a] [B]	16.46 [b] [B]	8.20 [c] [B]	8.35 [c] [B]	0.959

a,b – estimated mean values between groups (lines) differ statistically significantly ($P \leq 0.05$).
A,B – estimated mean values within groups (columns) differ statistically significantly ($P \leq 0.05$).

The highest percentage of subcutaneous fat found in D+ females significantly differed from other groups in the trial. Inside all the groups, animals of different ages significantly differed in percentage of subcutaneous fat. The percentage of abdominal fat in carcasses increased with age (Table 5). Females D+ had significantly higher percentage of abdominal fat compared to males regardless the age. Females D- had higher percentage of abdominal fat in comparison to males while sexes differed

statistically significantly only at the age of 42 days. The percentage of total fat in carcasses increased with age (Table 5) as well. Higher percentage of fat in D+ carcasses might be the consequence of selection for higher body weight when animals were fed *ad libitum*. Several authors reported (Pym and Solvyns, 1979; Siegel and Dunnington, 1987) that such selection model meant an advantage to animals with good appetite, which on the other hand resulted in higher fattiness because animals consumed more food than they needed. Although Katanbaf et al. (1988) reported that the effects of divergent selection for body weight at the age of 8 weeks did not show an increase in absolute amount of fat per unit of body weight in the upwards selected line compared to downwards selected line; our results did not support the mentioned conclusions. Thus, in both ages the amount of fats (subcutaneous, abdominal and total) calculated to unit of body weight was higher in animals selected for higher body weight (Table 6).

Table 6 The amount of fats (g/g body weight) in chicks of two genotypes, sexes and at two different ages

Trait	Age (days)	D+		D-	
		Males	Females	Males	Females
Subcutaneous fat	42	0.0352	0.0439	0.0249	0.0314
	58	0.0644	0.0813	0.0463	0.0449
Abdominal fat	42	0.0242	0.0361	0.0070	0.0129
	58	0.0362	0.0479	0.0149	0.0170
Total fat	42	0.0594	0.0800	0.0319	0.0445
	58	0.1005	0.1292	0.0612	0.0618

Shares of *m. pectoralis superficialis* and *m. pectoralis profundus* in the carcass increased with age (Figure 1). The comparison of animals of the same sex from both lines at fixed age showed that the share of *m. pectoralis superficialis* in carcass increased while the share of *m. pectoralis profundus* decreased in the selection for high body weight at the age of 8 weeks. Relative increase of *m. pectoralis superficialis* and *m. pectoralis profundus* weight in D- line was higher between 42 and 58 days of age compared to D+ line (Table 7). The percentage of skin in chick carcass decreased with age in all groups. Females had higher percentage of skin in carcass compared to males of the same line. At the age of 42 days the proportion of skin in the carcass amounted to 5.83 % (D+ males), 7.00 % (D+ females), 6.94 % (D- males), 7.82 % (D- females), at the age of 58 days the proportion was 3.38 % (D+ males), 3.22 % (D+ females), 4.66 % (D- males) and 4.77 % (D- females). Statistically significant differences were noticed between lines and within groups at different age.

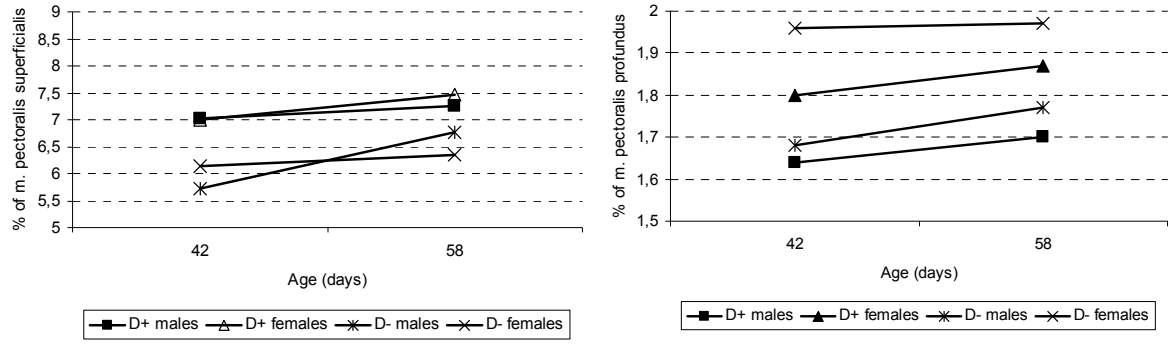

Figure 1. Changes in shares of *m. pectoralis superficialis* (left) and *m. pectoralis profundus* (right) in a chick carcass between age of 42 and 58 days

Table 7. Relative increase of *m. pectoralis superficialis* and *m. pectoralis profundus* weight between 42 and 58 days of age in divergently selected lines of chicks

Age (days)	D+		D-	
	Males	Females	Males	Females
42	100.0	100.0	100.0	100.0
58 (*m. pectoralis superficialis*)	164.7	163.2	212.3	191.6
58 (*m. pectoralis profundus*)	166.5	164.5	193.2	181.4

CONCLUSION

After 25 generations of divergent selection for body weight at 8 weeks of age in both lines the growth rate of chickens from 42 to 58 days of age was studied as well as changes in correlated traits like feed conversion, dressing out percentage, fat content in carcasses and percentage of some tissues and body parts respectively. The results show that divergent selection influences significantly body weight and body composition as well. The selection for higher growth rate causes higher fat content in a carcass, and a higher share of *m. pectoralis superficialis*, whereas the share of skin in a carcass decreased.

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REFERENCES

1. Dunnington E. A., Siegel P.B. (1996): Long-term divergent selection for eight-week body weight in White Plymouth Rock chickens. Poultry Science, 75: 1168-1179.
2. Katanbaf M. N., Dunnington E. A., Siegel P. B. (1988): Allomorphic relationships from hatching to 56 days in parental lines and F_1 crosses of chickens selected 27 generations for high or low body weight. Growth, Development and Aging, 52: 11-22.
3. Pym R., Solvyns A. (1979): Selection for food conversion in broilers: Body composition of birds selected for increased body-weight gain, food consumption and food conversion ratio. Br. Poult. Sci. 20: 87–97.
4. SAS/STAT User's guide. (1990): Version 6. 4th ed. Cary SAS Institute Inc.: 893-993.
5. Siegel P. B., Dunnington E. A. (1987): Selection for growth in chickens. Critical Reviews in Poultry Biology, 1:1-24.

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